

From: **Steve Thurston** <thurston.steve@gmail.com>
Date: Thu, Feb 19, 2009 at 8:18 AM
Subject: Fwd: Thurston/James submission RHW noise
To: "Beth.Callahan@maine.gov" <Beth.Callahan@maine.gov>
Cc: Rick James <rickjames@e-coustic.com>

Hi Beth,

Thanks for the meeting last night. I hope you agree that the testimony you received was sufficient to justify the meeting, and even perhaps a public hearing. I'm not sure of the difference. Perhaps you could explain it?

I spoke with Warren Brown after the meeting. He agreed to review the noise information I submitted including the Richard James' piece, and he also agreed to share the information he has requested from RHW with Mr. James.

The attached files contain my testimony on noise and accompanying exhibits, including Richard James' report. The State Planning Office Technical Assistance Bulletin #4 - Noise can be found here: <http://www.state.me.us/spo/landuse/docs/techassist/techassistbulletins/noisetabulletin.pdf>

Would you please forward this to Mr. Brown with a cc to me and Richard James?

Steve

Section 5. Noise

Noise is the most significant impact that Roxbury faces from this project. The health and well being of the community is in the hands of the DEP. Experience with other communities such as Mars Hill in Maine, and hundreds of communities throughout the world show that the presence of turbines near homes can be catastrophic for the residents of these homes, and in some more sensitive individuals trigger medical pathology. Therefore it is of utmost importance that the noise emitted by the wind turbines proposed by RHW is thoroughly understood. Findings of fact must show that the community will not be subject to noise, or other forms of acoustic energy which will cause harm in any way.

The Maine State Planning Office publishes a Technical Assistance Bulletin on Noise (TAB-N) (Exhibit H attached). It was written in 2000, prior to wind turbine projects' recent proliferation in the state. Were it to be written today, no doubt there would be a discussion of the impact of wind turbine noise on communities, because there is a wealth of literature on the subject indicating that turbines pose real and present danger to the health of people who spend significant amounts of time near these enormous machines, whose size is only restricted by the physical limitations of the technology to accommodate the tremendous forces they must overcome.

Quoting from the TAB-N,

"Prolonged noise exposure is a serious threat to human health; it can result in high stress levels and, at high sound levels, impaired hearing. Common environmental noise sources can cause or contribute to stress-related illnesses such as cardiac and circulatory diseases. Noise can also negatively impact concentration, communication, and sleep creating annoying and sometimes even hazardous conditions. These factors are important in setting noise standards for the community. It may be important to protect certain uses such as offices, schools, and churches from significant noise increases to allow effective communication. It is also important to protect neighborhoods so that residents can communicate and enjoy their property. Residential areas should also be protected from noise so that residents are able to obtain uninterrupted sleep. Interrupted sleep can result in serious health impacts and also affect personal safety at home and at work. Another consideration for municipal officials is property values. Neighborhoods subject to noise disturbance will generally have lower values."

The number one complaint of people living near turbines is sleep deprivation. Sleep deprivation is a form of torture used at Guantanamo Bay until recently when it was banned by President Obama as one of his first acts as President.

The World Health Organization recognizes the special place of low frequency noise as an environmental problem. Its publication "Community Noise" (Berglund et al., 2000) makes a number of references to low frequency noise, some of which are as follows:

- "It should be noted that low frequency noise... can disturb rest and sleep even at low sound levels.
- For noise with a large proportion of low frequency sounds a still lower guideline (than 30dBA) is recommended.
- When prominent low frequency components are present, noise measures based on A-weighting are

inappropriate.

- Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting.
- It should be noted that a large proportion of low frequency components in a noise may increase considerably the adverse effects on health."

WHO also states: "The evidence on low frequency noise is sufficiently strong to warrant immediate concern." Available at <http://www.who.int/docstore/peh/noise/guidelines2.html>,
References found at pages ix, xii through xv and others."

Roxbury is a rural community, devoid of factories or persistent industrial noise of any kind except for the sound of logging operations on the mountains which occurs only during the day. Night time at Roxbury Pond can be described as "dead quiet". The distant cry of a loon pierces the silence and can wake a person from a sound sleep if a bedroom window is open.

When the Telstar bubble was in existence at the Andover Earth Station, 3 miles away from our residence on the east shore of Roxbury Pond, on a typical quiet night the sound of the compressor which kept the bubble inflated could be heard faintly coming from that direction as a "put, put, put" sound. When you visited the Telstar installation during the daytime, you were not aware of the compressor noise because of the much higher ambient noise levels including cars entering and leaving and people talking, even though the compressor was within a few hundred feet. This goes to show just how quiet it becomes at night.

TAB-N contains a table titled "Common Sound Levels". 20 dB is the sound pressure level listed for "quiet house interior or rural nighttime".

Common Sound Levels

<i>Sound Environment Sound Pressure Level (Dba) Threshold of hearing</i>	0	
<i>Broadcast studio interior or rustling leaves</i>	10	
<i>Quiet house interior or rural nighttime</i>		20
<i>Quiet office interior or watch ticking</i>	30	
<i>Quiet rural area or small theater</i>	40	
<i>Quiet suburban area or dishwasher in next room</i>	50	
<i>Office interior or ordinary conversation</i>	60	
<i>Vacuum cleaner at 10 ft.</i>	70	
<i>Passing car at 10 ft. or garbage disposal at 3 ft.</i>	80	
<i>Passing bus or truck at 10 ft. or food blender at 3 ft.</i>	90	
<i>Passing subway train at 10 ft. or gas lawn mower at 3 ft.</i>	100	
<i>Night club with band playing (or a wind turbine)</i>	110	
<i>Threshold of pain</i>	120	

Experience has shown that the Roxbury Pond area accurately fits the description of "rural nighttime" and therefore a dB level of 20 can be relied upon with confidence, despite the noise levels measured by RHW as part of its noise study, which lacked appropriate procedures and methodologies for accurately measuring ambient noise levels as will be discussed in detail further down.

TAB-N goes on to say, "In addition to the three (3) components (intensity, frequency,

and duration), the time of day that the noise occurs also contributes to the degree of disturbance and its impacts. **Nighttime noise is more annoying than daytime noise and may cause more noticeable health impacts through the disruption of sleep.** Thus, most standards provide a daytime criteria and a nighttime criteria, although the time periods vary from one municipality to another and may even vary by zone within a municipality....Due to the logarithmic nature of noise measurement and the way noise levels are perceived by humans, care must be taken in using absolute limits."

The following table from TAB-N provides some typical human perceptions of noise increases.

PERCEPTIONS OF NOISE INCREASES

Increase in Noise Level (dBA)

Human Perception

0 to 2 Not usually noticeable

3 Just noticeable

6 Clearly noticeable

10 Twice as loud

20 Four times as loud

If the noise standard sets a 65 dBA threshold for a rural area, but the background noise in the rural area is currently only forty-five (45), then the ordinance would permit an increase in noise level of 20 dB, perceived as a 4-fold increase. Thus, residents in the area would perceive a very significant increase in noise. However, unless extreme protection is warranted, limiting increases, especially daytime increases, to less than 5 dB is not generally recommended.

7.4 Short Duration Repetitive Sound

From RHW's noise study:

Short Duration Repetitive and Tonal Sounds - When routine operations produce a short duration repetitive or tonal sound, 5 dBA is added to the observed sound levels of these sounds for determining compliance. There is also a maximum sound level (L_{Amax}) limit for certain types of short duration repetitive sounds (ref. DEP 375.10.C.1.d and e).

7.4 Tonal and Short Duration Repetitive Sound

Short duration repetitive (SDR) sounds are a sequence of sound events each clearly discernible that causes an increase of 6 dBA or more in the sound level observed before and after the event. SDR sound events are typically less than 10 seconds in duration and occur more than once within an hour. Published studies of noise from wind turbine operations indicate that sound levels can fluctuate over brief periods as noted by the passage of wind turbine blades and typically range from 2 to 4 dBA.1 Consequently, RHW operations are not expected to result in the 6 dBA increase required to be SDR sounds as set forth in DEP 375.10.

RHW's noise study claims that turbine noise will be less than the 45 dB nighttime limit, but no allowance is made for the repetitive sound that is the hallmark of turbines, the thumping noise

produced by the 8 ton, 150' long blades ripping through the air molecules at tip speeds of 200 mph, pushing out a low frequency wave that is perturbed with each pass of the blade in front of the tower. Maine's noise regulations require a 5 dB penalty to be added to the predicted sound level to adjust for this type of repetitive sound. For RHW to take the position that somehow wind turbines should be exempt from this requirement is absurd. **Other studies show that 5-6 dB is common and 10-15 dB is possible.**

Easements for Excessive Noise at Protected Properties and Protected Locations

From RHW's noise study:

Record Hill Wind, LLC holds a lease with a local landowner to install and operate wind turbines at the proposed locations. Record Hill Wind, LLC is pursuing other agreements with abutting landowners. Parcels for which the developer has a lease, easement or pursuing other agreements in the vicinity of the project are indicated on Figure 3-1.

There have been no easements recorded in the town records to indicate that agreements have been reached with landowners of protected properties. The letter from David Hodgkins is not a legally binding document.

Predicted Noise Levels Are Flawed

The RHW noise study erroneously predicts that the 45 dB nighttime limit will not reach homes in Roxbury. Multiple turbines in a line perpendicular to protected properties require a change to the doubling/distance formula from 6 dB per doubling of distance to 3 dB. This correction to the RHW model shows that many homes will be within the 45 dB maximum nighttime limit.

One example is the homes on RT 120 that about 3000' - 3500' from and in a direct line of sight to the proposed turbine location on the top of Partridge Peak. Two of these homes are shown on scale drawing Exhibit G, which was created by using the contours shown on the site location map in conjunction with Mapper software to find exact horizontal and vertical distances from turbines to houses. There is no terrain or vegetation which will attenuate the sound from either of these houses. They are in a direct line of sight to the rotor hubs of turbines #20 and 21. These homes are staring directly at the turbines and are about the same distance from them as homes on Mars Hill that have measured noise levels in excess of 50 dB. The turbines at Mars Hill are smaller and quieter than the turbines proposed by RHW. By correcting the noise contours as shown on Exhibit B we can see that both of these home, and several others are in areas where turbine noise is expected to be in excess of 47 dB.

Another example is homes along the shore line of Roxbury Pond in the general vicinity of RH 5 monitoring station. The turbines in the string on Flathead Mountain all face this area. The cumulative increase in the sound from multiple turbines requires that a 3 dB decrease for every doubling of distance is used, not a 6 dB decrease. This puts the 45 dB limit line beyond numerous homes in the area of RH 4, in fact it is well beyond French Island See map exhibit A.

As a double check on the anticipated noise level from the turbines I drew Exhibit E using the same parameters as Exhibit G, which corresponds to the relationship of any of the three turbines on either side of the turbine on the peak of Flathead Mountain. All six of these turbines are about the same distance, 1.2 miles, from the house at the top of Ellis Hill road. The contours are very even with a slight flattening of the grade near the house as the gentle curve shows. On this drawing I included the top of the tree line to show that attenuation from vegetation at this house will be minimal. Using the online calculator shown

on Exhibit F and converting feet to meters, the sound level from one meter in front of the turbine hub per Clipper Windpower's specifications to the house calculates to 47.7 dB. This simple calculator does not recognize the 3 dB decrease which should be applied due to multiple noise sources from many turbines which would have caused a higher decibel level to be calculated at the protected location., and it simply shows that the corrected contour maps I have provided are reasonably accurate.

Note the descriptions of nearby point sources of noise in the ambient sound tests. These tests are designed to find the lowest levels of nighttime sound and point sources such as flowing streams, water dripping from trees, owls, frogs, and waves should not be allowed to affect the measurements. Including these point sources masks the actual lowest levels of nighttime noise and shows that the test sites were not properly selected to represent background ambient conditions but instead were selected to permit nearby noises to artificially inflate readings.

*At position RH-3, daytime hourly LAeqs ranged from 38 to 62 dBA with an average LAeq of 43 dBA. Nighttime hourly LAeqs ranged from 34 to 58 dBA with an average LAeq of 40 dBA. Prominent sound sources observed at position RH-3 during daytime hours included birds, **a westerly flowing mountain stream** to the north and south of RH-3 and rustling leaves. During nighttime hours prominent sound sources noted included traffic, rustling leaves, **the stream**, and **water dripping from trees**, and birds at daybreak.*

*At position RH-4, daytime hourly LAeqs ranged from 39 to 87 dBA with an average LAeq of 52 dBA. Observations indicate substantial beach activity and ATVs were operating on and in the vicinity of the Public Boat Launch when the high end of the sound level range was recorded. Nighttime hourly LAeqs ranged from **26** to 53 dBA with an average LAeq of 39 dBA. Prominent sound sources observed at position RH-4 during daytime hours included activity from the boat launch and the beach, ATVs on the boat launch and on Shore Road, traffic on Shore Road and residential activity. Prominent sound sources noted during nighttime hours included **residential activity**, **owls**, **frogs** and **waves from Roxbury Pond**.*

Daytime readings are meaningless with regard to audible noise levels. Wind turbine audible noise will be a problem at nighttime, when it is quiet.

Residents of Roxbury will not be the victims of these deliberately overstated nighttime noise levels. Noise studies at Mars Hill underestimated the noise of the turbines, which have been measured at homes to be over 50 dB for long periods. The same firm produced the pre-construction ambient noise study and predicted the noise level of the turbines at Mars Hill and Record Hill. Clearly there is a flaw in the methodology and practices used by this company.

Wendy Todd's experience in Mars Hill is typical of the reports from many people living near wind turbines. Her house is 2600' from the nearest turbine. There are 18 families on Mars Hill that are negatively impacted on a regular basis from the noise, strobe effect and shadow flicker from the turbines.

I have never met Wendy Todd, but learned of her by way of her testimony to the Governor's Task Force on Wind Power. I wondered how things were going on Mars Hill after more than a year living

with the Mars Hill wind project nearby. I contacted Wendy recently and she sent me this email today 2/16/09:

Steve,

Health issues from headaches to vertigo have been testified to for over a year now. It seems amazing to me that Jim Cassida, permitting coordinator for the DEP was quoted as saying that there haven't been any health concerns mentioned in Mars Hill. WOW, where has he been.

The group here in Mars Hill has a full range of symptoms related to turbines. It affects different people in different ways. Richard Fletcher, ringing in the ears - Diane Glidden, sleep aids and prescription for headaches - Charles Radell - professional counseling for depression and help with anger - Dorothy Miles, increased migraines, changes to prescriptions to help, skin condition from the stress of little sleep and aggravation from the noise and shadow flicker - Lorraine Tardy, aggravated migraines, changes to medication - Merle Cowperthwaite, on and off depression medication and so on.

I have been offered depression medication from my doctor to help handle the mental aspect of this nightmare but I have never opted to start. Both Perrin and I have had headaches, sleepless nights that turn into anger, frustration and rage. I have experienced ringing in the ears on really bad days and have had a couple of times when my eyes twitch uncontrollably for no reason other than the stress of the turbines wailing and thumping for days on end. The shadow flicker and days with heavy blade thump create a sense of unbalance and dizziness for our family and has been experienced by many others in the group.

Most families have had to adjust how they live in their homes based on the noise and shadow flicker. Drawn curtains and blinds, fans or white noise machines by our bedsides, earplugs and so on have become reality for most. Keep in mind that even after those adjustments there are still nights when the noise from the turbines will wake you and then keep you awake with the repetitive thumping. It is so much more than a nuisance. It alters your life.

There are people in the town of Blaine, who live on Libby road, 3+ miles away who hear the turbines and more on route 1A in Mars Hill who hear them as well. These folks live anywhere from 2 1/2 to 3 1/2 miles away and on the upwind side of the project. That will give you an idea of what people who are downwind of the project and under a half mile deal with. And to think that the industry still gets away with saying things like, "They are no louder than your refrigerator."

Maine is a winter and night resource for wind. It is always worse in colder months and at night. Tell that to those who visit a turbine facility on a pleasant day in June and July and say "We have visited a facility and there is no issue with noise". Most people have no idea how many variables go into the noise issue. I am sorry but even Rob and Angus are still in the dark about the truth about the noise. They have listened to the industry and put more weight there than they should.

Sorry to go on so - It just seems that the voices of Mars Hill have gone unheard.
Wendy Todd

RHW's principals Angus King and Rob Gardiner held several informational meetings at the Roxbury Town office to present their project to the town. On at least two occasions, in response to questions about the sound that people would hear from the turbines, Angus King responded by asking everyone in the room to be as quiet as possible (dead quiet) while his "sound man" checked the noise level. The noise of the quiet room was then compared to the sound of the turbines. If this demonstration represents the truth, there is no reason that residents of Roxbury should expect to be subjected to **any**

persistent noise from turbines. Dead quiet evenings are just that. Any man made, persistent, repetitive, thumping, whumping, whining, grinding noise that exceeds this dead quiet by more than 5 decibels, the point at which noise becomes "clearly noticeable" according to Maine's Technical Bulletin on Noise, will be create an **undue adverse impact on the rural character of the area and cannot be permitted.** We refuse to become the next Mars Hill!

By now it should be understood by everyone at DEP that MDEP's noise regulations do not anticipate the type of noise emitted by wind turbines and do not adequately protect Maine communities from this noise. Citizens of Roxbury have the right to fully expect the DEP to fulfill its role as the protector of Maine's environment. Noise pollution from wind turbines carries with it the potential for drastic social impacts that Maine's health care system can ill afford to assume. From sleep deprivation and the cascade of health impacts that result, to cardiac irregularities, migraine headaches, and vertigo, to name but a few, the stage is set for dozens of Maine's communities to be placed at risk by the sudden invasion of the state by the wind industry. As the guardians of our environment, DEP cannot allow this to happen.

TAB-N provides additional noise standards for situations such as Roxbury:

Additions to Basic Standard

Additional standard #5 provides additional protection to areas of the community where the ambient sound level is considerably below the allowed level.

When a proposed development is to be located in an area where the daytime pre-development ambient hourly sound level (Leq 60) is equal to or less than 45 dBA and/or the nighttime pre-development ambient hourly sound level is equal to or less than 35 dBA, the hourly sound level resulting from the development shall not cause the ambient hourly sound levels at the property lines of the development to be 5 dBA more than the ambient hourly sound level prior to development.

This standard limits the sound level emitted by new development in areas of a community that are particularly quiet. It provides for a 5 dB increase in ambient sound levels above the pre-development level. Thus, the increase will be noticeable, but it should not create a significant disturbance. It provides significant protection from noise intrusion.

As previously discussed, RHW's noise study employed improper method and procedures for determining ambient nighttime hourly sound levels. Point sources of noise were included in the data collected. Without requiring additional noise collection to be made, the DEP cannot conclude that RHW's noise study represents the present day environment at Roxbury Pond. However, if the TAB-N standard of 20 dB in rural nighttime locations is agreed to by the DEP and RHW, and the additional condition of no more than a 5 dB increase at the property lines is permitted, Roxbury will be sufficiently protected from the type of intrusive noise that Mars Hill residents are being subjected to on a daily basis.

It is only reasonable and prudent for the DEP, in its fact finding, to conclude that such a condition is both desirable and necessary to avoid ongoing community wide health problems as a result of this project.

There are several ways that such protections could be implemented. One way is to use turbines that are capable of being controlled by remote sensors that will continuously measure wind speeds at Roxbury Pond and slow or stop the turbines when wind speed at the surface of Roxbury Pond decreases to the point at which turbine noise will exceed background noise by more than 5 dB. Nordex is one turbine manufacturer that offers such a control system.

This type of control system, if implemented properly, would protect Roxbury from objectionable audible noise levels. If such a control system were in place at Mars Hill, perhaps the problems residents there are facing could have been avoided.

Without some means of preventing unacceptable noise levels at night the only other alternative is for the project to be denied, or abandoned by the applicant, whichever comes first.

Note: This Section has been developed with the assistance of Mr. Richard R. James, INCE, an acoustical engineer with over 35 years of experience with community noise, land-use planning, use of computer models for estimating the impact of a new noise source on a host community, measurement of background sound levels to establish the ambient conditions prior to construction and operation of a new noise source, and post construction measurements to assess compliance of the new project. He, along with his collaborator, Mr. George Kamperman, PE., Bd. Cert. INCE (emeritus) is also co-author of a recent research study titled: "How to' Guide to Siting Wind Turbines to Prevent Health Risks from Sound.." Mr. James has reviewed and approved of the information provided in Section 5. and has also submitted written testimony with additional supporting information.

Mr. James knowledge and expertise in wind turbine noise issues has been very helpful to me, and I believe the DEP would be wise to consult him as modifications to Maine's noise regulations are considered.

Richard James, E-Coustic Solutions.
Tel: (517) 507-5067
Fax: (866) 461-4103
Email: rickjames@e-coustic.com

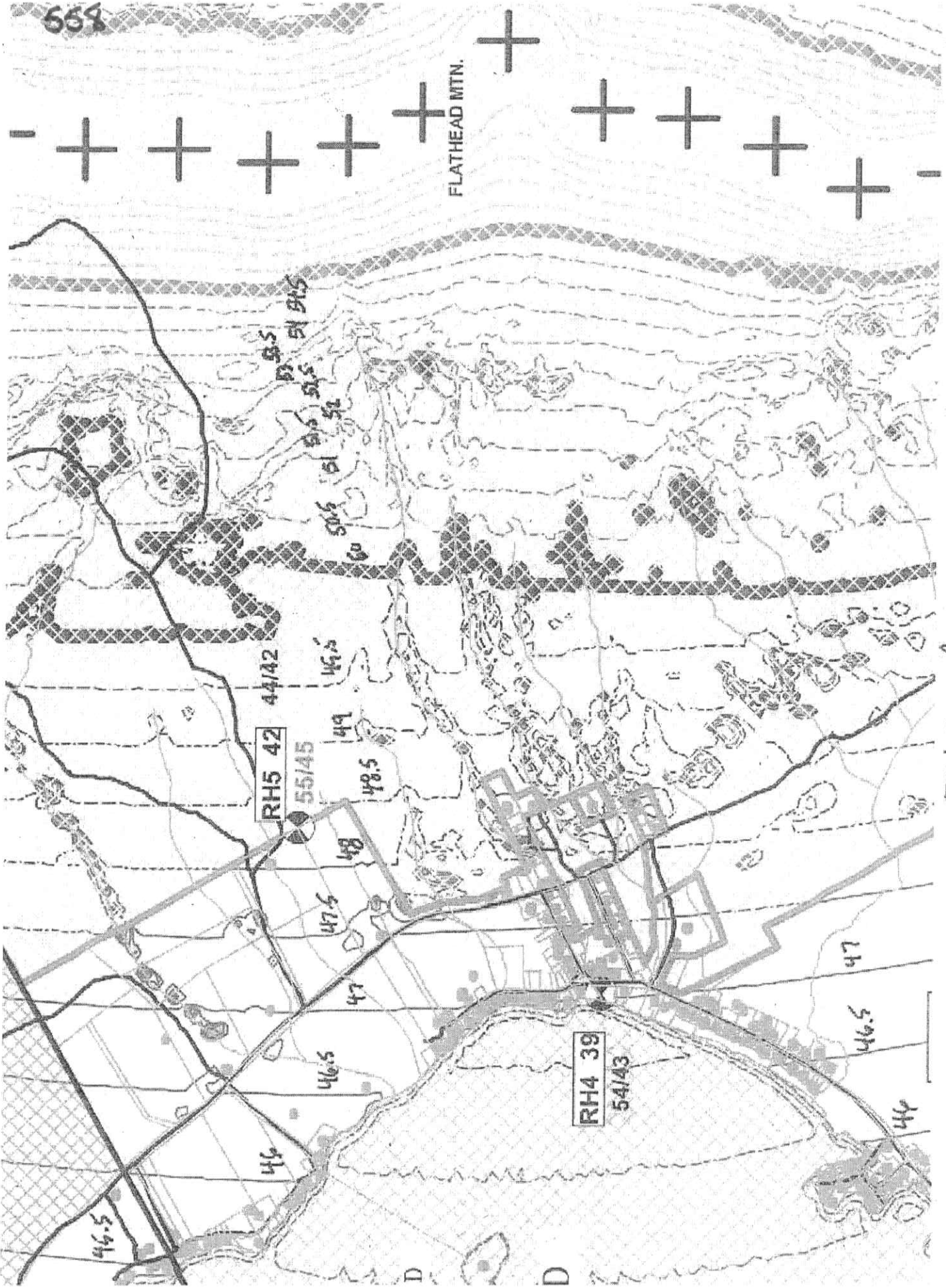
Note: Exhibit C and D are included to indicate the actual decibel levels to be expected from turbine noise at protected properties and protected locations as indicated.

Testimony submitted by Steve Thurston
Sunset Cove, Roxbury Pond
and on behalf of Concerned Citizens to Save Roxbury

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FLATHEAD MTN.

EXIST A



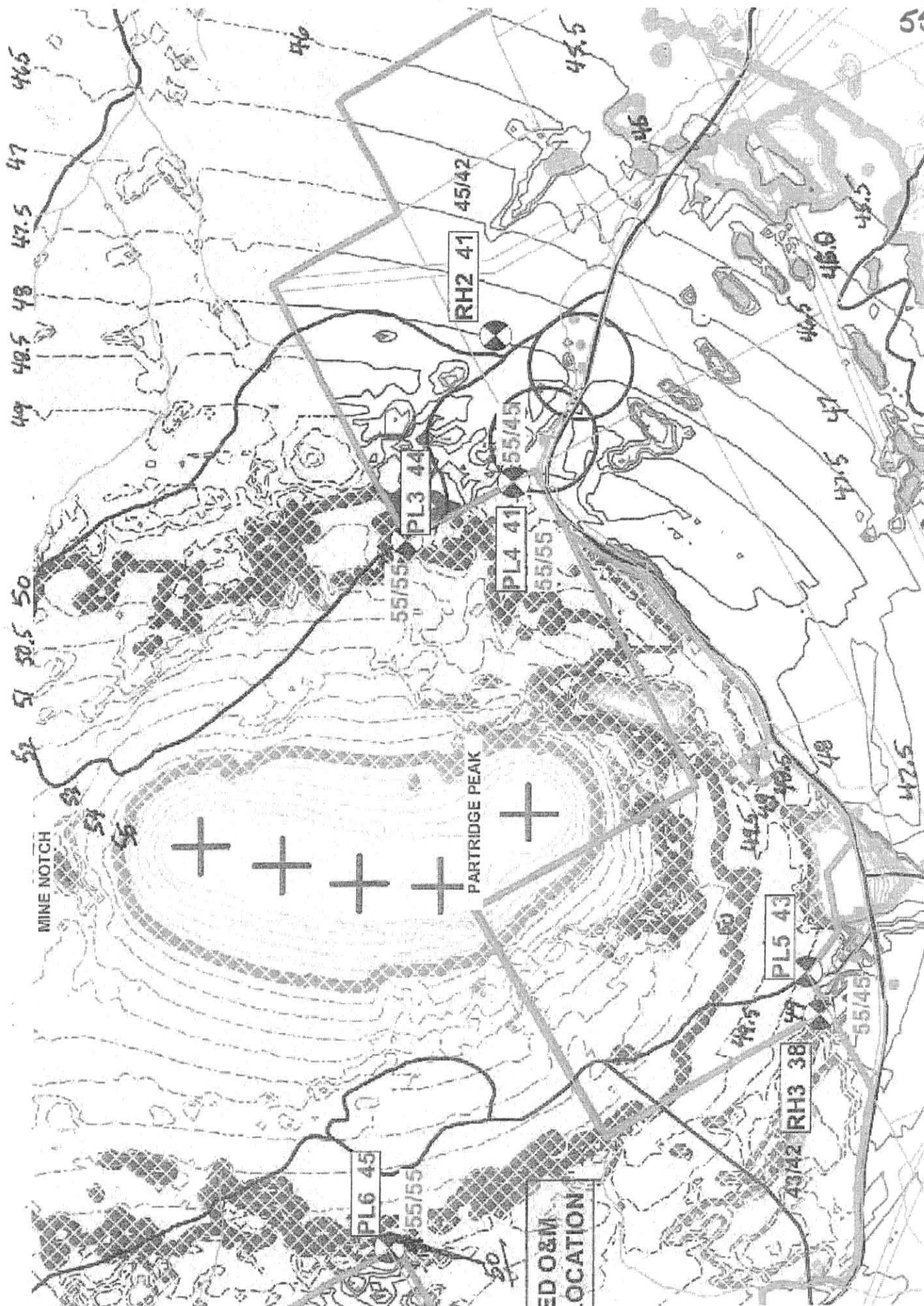


EXHIBIT B

Referring to the Vicinity Site Plan (Figure 3-1), existing (ambient) sound levels were measured at five community positions in the vicinity of RHW. All the measurement positions were selected to represent existing sound levels within 500 feet of nearby dwellings as follows:

Position	Description
RH-1 Actual 48 dB	Located in a field near a residential property on Roxbury Road (Route 17). Position RH-1 represents ambient sound levels at the nearest residential property east of RHW in the village area. RH-1 is approximately 402 ft. above msl, approximately 320 ft. west of the centerline of Route 17, located within 250 ft. of a nearby dwelling and 7,500 ft from the nearest proposed wind turbine. RH-1 is farther from Route 17 than the nearest dwelling.
RH-2	Located east of Partridge Peak. Position RH-2 represents the ambient sound levels at protected locations, east of the south end of the proposed turbine array and north of Roxbury Notch Road. RH-2 is approximately 962 ft. above msl, 1,100 ft. north of the centerline of Roxbury Notch Road (Route 120) and 4,500 ft. east of the nearest proposed wind turbine on Partridge Peak. RH-2 is approximately 750 feet farther from the road and 550 ft. farther from a mountain stream than the nearest dwelling. As a result, RH-2 would tend to understate the existing sounds at the nearby dwellings.
RH-3 48.5	Located southwest of Partridge Peak. Position RH-3 represents ambient sound levels at protected locations south of the wind project along Roxbury Notch Road. RH-3 is approximately 1300 ft. above msl, 530 ft. north of the centerline of Roxbury Notch Road, 3,400 ft. from the nearest proposed wind turbine on Partridge Peak, and within 450 ft. of a nearby dwelling.
RH-4 47	Located at the Public Boat Launch facility on Roxbury Pond. Position RH-4 represents ambient sound levels at residential properties west of the proposed wind project along the east shore of Roxbury Pond. RH-4 is approximately 790 ft. above msl, 350 ft. west of the centerline of Shore Road, 30 ft. from the nearest dwelling and 7,500 ft. from the nearest proposed wind turbine.
RH-5 48	Located in a former log yard. Position RH-5 represents ambient sound levels at the nearest residential properties west of the RHW turbine array between Record Hill and Flathead Mountain. RH-5 is approximately 1,100 ft. above msl, 1,600 ft. east of the centerline of Shore Road, 400 ft. from the nearest dwelling and 6,000 ft. from the nearest proposed wind turbine.

EXHIBIT C

Table 3-2
RHW Hourly Sound Level Limits (dBA)

Protected Location ^A	Description	Approximate Distance From Nearest Wind Turbine (ft)	DEP Hourly Limit (dBA) Daytime	Nighttime	Limit Basis
PL1	Northeast of Turbine 1, on the Roxbury/Byron Town Line and Property Line of project	6,000 (1,800 m)	55	55 ^B	Residential Property Line >500 ft from Dwelling
PL2	Northeast of Flathead Mtn. at Property Line and Residential Lot Line	6,800 (2,100 m)	55	55 ^B	Residential Property Line >500 ft from Dwelling
PL3 50	East of Partridge Peak at Property Line	2,800 (900 m)	55	55 ^B	Residential Property Line >500 ft from Dwelling
PL4 48.5	East of Partridge Peak at Property Line	3,100 (1,000 m)	55	45	Residential Property Line within 500 ft of Dwelling
PL5 49	South of Partridge Peak, Property Line	3,100 (900 m)	55	45	Residential Property Line within 500 ft of Dwelling
PL6	West of Partridge Peak, Property Line	3,500 (1,100 m)	55	55 ^B	Residential Property Line >500 ft from Dwelling
PL7	Southeast Shore of Roxbury Pond, Residential Area	8,100 (2,500 m)	55	45	Residential Property Line within 500 ft of Dwelling
PL8	Southwest Shore of Roxbury Pond, Residential Area	11,500 (3,500 m)	55	45	Residential Property Line within 500 ft of Dwelling
PL9	Northwest of Turbine 1, along the East Shore of Little Roxbury Pond (Residential Area in Byron)	11,300 (3,400 m)	55	45	Residential Property Line within 500 ft of Dwelling

^A See Figure 3-1, Vicinity Site Plan.

^B Applies at property boundary and when ≤500 feet to dwelling 45 dBA.

EXHIBIT D

Actual dB

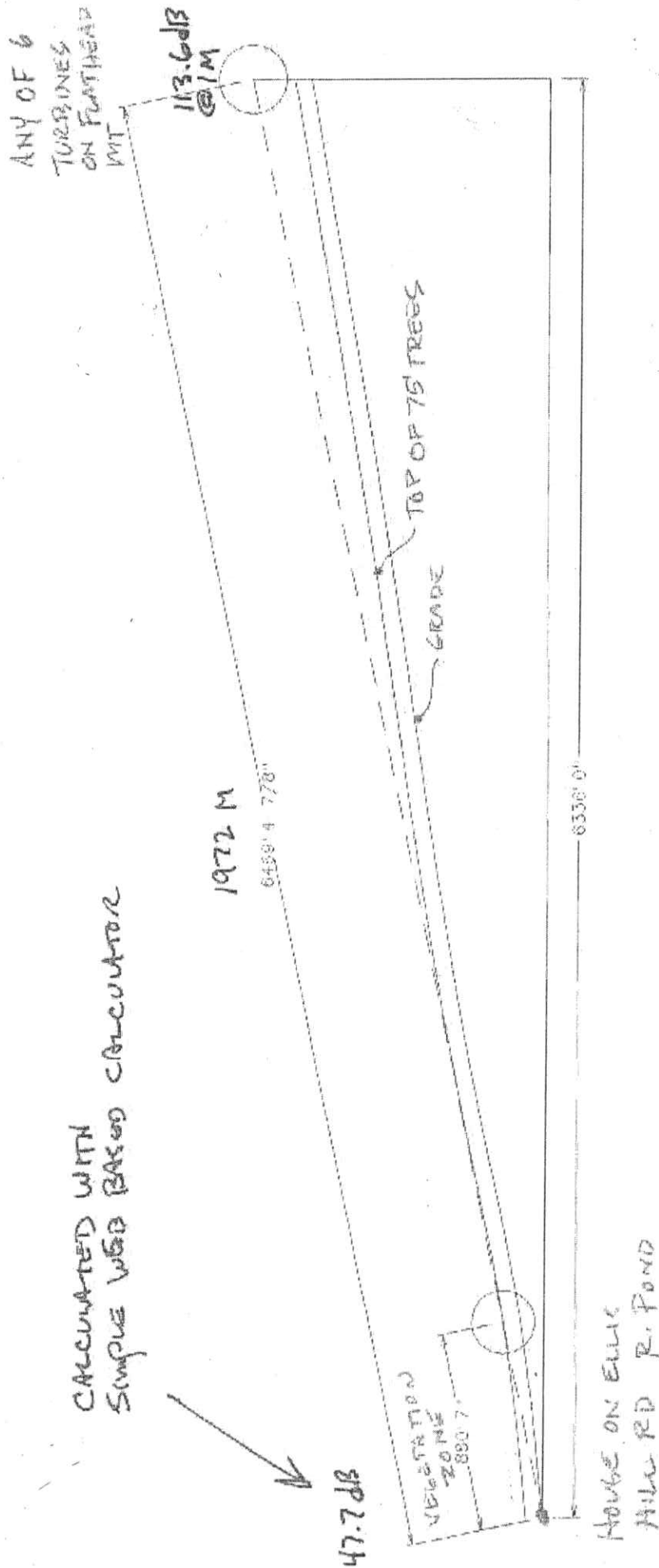


EXHIBIT G

Tontechnik-Rechner - sengpielaudio

Page 3

Deutsche Version

• Damping of sound level with distance •

Changing of sound pressure level ΔL or sound pressure with distance r in a free field (direct field), like in anechoic chambers

Conversion: Distance values \rightarrow Level changingWith sound level we usually mean a level ratio of sound pressure

These calculations are meant only for engineers and the distance from a musician or a loudspeaker to a microphone in a direct field -

No air damping and frequency dependence of e.g. the thunder in a distance.

Enter the three gray boxes and you get the amount of attenuation, you can expect with a change in sound source distance, in a free field.

Reference distance r_1 from source 1.00 m or ft	Sound level L_1 at reference distance 113.6 dB SPL	The $1/r$ law. There is really no square and no power!
New distance r_2 from source 1972 m or ft	Sound level L_2 at new distance: 47.7 dB SPL	Sound level difference $\Delta L = L_1 - L_2$ 65.9 dB
calculate	reset	

The sound pressure p changes with $1/r$ of the distance.

Sometimes it is said, that it goes with $1/r^2$. That is really wrong.

But the sound intensity (energy quantity) decreases with $1/r^2$. Intensity is not pressure.

The sound pressure level shows in the free field situation a reduction of 6 dB per doubling of distance; that means the sound pressure value is a half and not a quarter.

$$\text{Sound level difference: } \Delta L = 20 \cdot \lg \frac{r_2}{r_1} \text{ or level at far distance } L_2 = L_1 - 20 \cdot \lg \frac{r_2}{r_1}$$

$$\Delta L = L_1 - L_2.$$

The sound pressure p decreases really with $1/r$ from the sound source!

$$\begin{aligned} p &\propto \frac{1}{r} \\ \frac{p_1}{p_2} &= \frac{r_2}{r_1} \\ p_1 &= p_2 \cdot r_2 \cdot \frac{1}{r_1} \end{aligned}$$

In acoustics, the sound pressure of a spherical wave front radiating from a point source decreases by a factor of 1/2 as the distance is doubled.

The behavior is not inverse-square, but is inverse-proportional:

$$p \sim 1/r$$

Relation of sound intensity I , sound pressure p and the distance law -

EXHIBIT F

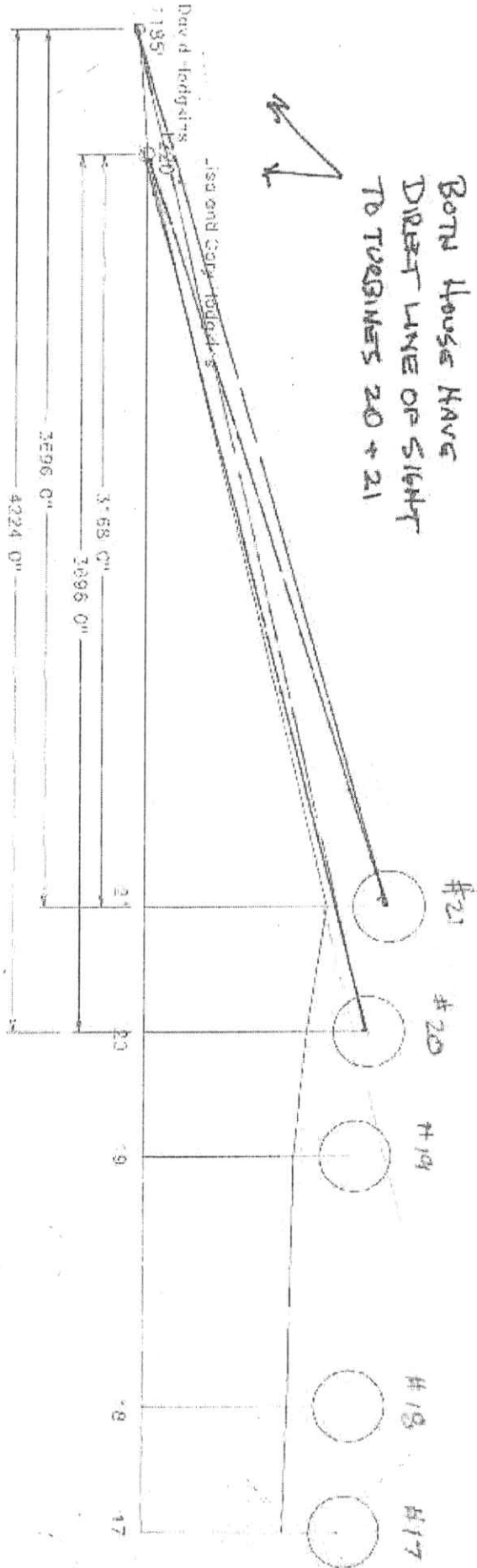


EXHIBIT G